PROGRAMA DA DISCIPLINA/TURMA 3ZA PERÍODO: 2025.2

MAT 2930	**TÓPICOS DE EQUAÇÕES DIFERENCIAIS I** CARGA HORÁRIA TOTAL: 45 HORAS Nº CRÉDITOS: 3 PROFESSOR: Sergey Tikhomirov
TÍTULO DA DISCIPLINA:	**Solving differential equations with machine learning**

OBJETIVOS DA DISCIPLINA/TURMA	Study basics of applying of machine learning technics for solving ordinarily differential equations and partial differential equations
EMENTA DA DISCIPLINA	In the last years machine learning becomes a major tool in a lot of practical disciplines. In the course we consider applications of such type of techniques for numerical simulation of ordinarily partial differential equations. The main difference with the classical learning is that instead of trainining dataset we use differential equations. In the course we would consider 3 main techniques Residual Neural Networks (ResNets), Physically inspired neural networks (PINNS), and Gaussian-process regression. We would consider theoretical basis as well as positive (and negative) examples of applications.
PRÉ-REQUISITOS DA DISCIPLINA	Ordinarily differential equations, Probability
PROGRAMA DA DISCIPLINA/TURMA	The topics includes -- Basics of neural networks -- Basics of numerical methods for ODE -- Residual neural networks -- Solving ODE with residual neural networks -- Neural networks as universal approximator -- Physically inspired neural networks -- elliptic equations -- parabolic equations -- Bayesian method -- Basics of Gaussian Fields -- Gaussian-process regression
AVALIAÇÃO DA DISCIPLINA	Critério 12 Média = G1
DETALHAMENTO AVALIAÇÃO DA DISCIPLINA	

BIBLIOGRAFIA BÁSICA DA DISCIPLINA	Hennig, Philipp, Michael A. Osborne, and Hans P. Kersting. *Probabilistic Numerics: Computation as Machine Learning*. Cambridge University Press, 2022. Mathematical Introduction to Deep Learning: Methods, Implementations, and Theory, Arnulf Jentzen, Benno Kuckuck, Philippe von Wurstemberger, 2025 Gaussian Processes for Machine Learning, C. E. Rasmussen & C. K. I. Williams, MIT Press, 2006
BIBLIOGRAFIA COMPLEMENTAR DA DISCIPLINA	Parallel Computing and Scientific Machine Learning (SciML): Methods and Applications, Chris Rackauckas, https://book.sciml.ai/ Differential Equations for Continuous-Time Deep Learning, Lars Ruthotto, https://arxiv.org/pdf/2401.03965
BIBLIOGRAFIA DE PESQUISA DA DISCIPLINA	